Specific Heat Capacity – Worksheet 1

1. In kJ, how much heat is required to raise the temperature of 1.23 kg of water from 23.6 °C to 84.9 °C? (317 kJ)

$Q = ?$
$m = 1.23\ Kg$
$c = 4200\ J/Kg\,°C$
$T_i = 23.6°C$
$T_f = 84.9°C$

$Q = mc\Delta T$

$Q = 1.23\,Kg(4200\,J/Kg\,°C)(84.9°C - 23.6°C)$

$Q \approx 316675.8\ J$

$Q \approx 317\ KJ$

2. How much heat is needed to warm up 3.6 kg of hydrogen gas from 12.0 °C to 48.0 °C?

$Q = ?$
$m = 3.6\ Kg$
$T_i = 12.0°C$
$T_f = 48.0°C$
$c = 14400\ J/Kg\,°C$

$Q = mc\Delta T$

$Q = 3.6\,Kg(14400\,J/Kg\,°C)(48.0°C - 12.0°C)$

$Q \approx 1.8 \times 10^6\ J$

3. How much heat is released when a 260.0 g plate of copper cools from 5.30 x 10^2 K to 20.0 °C? (-24.0 kJ)

$Q = ?$
$m = 260.0\,g = 0.2600\,Kg$
$c = 390\ J/Kg\,°C$
$T_i = 5.30 \times 10^2\,K$
$T_f = 20.0°C = 293\,K$

$Q = mc\Delta T$

$Q = 0.2600\,Kg(390\,J/Kg\,°C)(293\,K - 5.30 \times 10^2\,K)$

$Q = -24031.8\ J$

$Q \approx -24.0\ KJ$

4. 3.4 kJ of heat is added to a 1.4 kg rod of uranium. What is the change in temperature the rod undergoes?

$Q = 3.4\,KJ = 3400\,J$
$m = 1.4\ Kg$
$\Delta T = ?$
$c = 210\ J/Kg\,°C$

$Q = mc\Delta T$

$\frac{Q}{mc} = \Delta T$

$\frac{3400\,J}{1.4\,Kg(210\,J/Kg\,°C)} = \Delta T$

$12\,°C \approx \Delta T$

5. 24 000 J of heat is released when 640 g of silver drops in temperature. If the silver was initially at -10.0 °C, what is the final temperature of the silver? (-170 °C)

$Q = -24\,000\,J$
$m = 640\,g = 0.640\,Kg$
$T_i = -10.0°C$
$T_f = ?$
$c = 230\ J/Kg\,°C$

$Q = mc(T_f - T_i)$

$\frac{Q}{mc} = T_f - T_i$

$\frac{Q}{mc} + T_i = T_f$

$\frac{-24000\,J}{0.640\,Kg(230\,J/Kg\,°C)} + (-10.0°C) = T_f$

$-170°C \approx T_f$

6. A mass of gold, initially at 540.0 °C, experiences a drop in temperature of 12.0 °C when 82.0 J of heat is released. What is the mass of the gold in grams?

m = ?
T_i = 540.0 °C
ΔT = −12.0 °C
Q = −82.0 J
c = 130 J/kg°C

Q = mcΔT

$\frac{Q}{c\Delta T} = m$

$\frac{-82.0\text{ J}}{(130\text{ J/kg°C})(-12.0\text{°C})} = m$

0.0523 kg ≈ m

m ≈ 52.3 g

7. 5.00 x 10^2 J of heat produces a temperature increase of 8.77 K in a 95 g sample of an unknown substance. What is the specific heat capacity? What is the substance? (6.00 x 10^2 J/kg°C)

Q = 5.00 × 10^2 J
ΔT = 8.77 K
m = 95 g = 0.095 kg
c = ?

Q = mcΔT

$\frac{Q}{m\Delta T} = c$

$\frac{5.00\times10^2\text{ J}}{0.095\text{ kg}(8.77\text{ K})} = c$

6.00 × 10^2 J/kg°C ≈ c

Glass

8. What is the difference between the amount of heat required to show an increase of 25.0 K thermometer containing 2.00 g of mercury and a thermometer made of the same mass of methyl alcohol? Be sure to take the larger number and subtract the smaller number.

ΔT = 25.0 K
Q = ?
m = 2.00 g = 0.002 kg
c = 140 J/kg°C
Q = mcΔT

Mercury
Q = (0.002 kg)(140 J/kg°C)(25.0 K)
Q = 7.0 J

Methyl Alcohol
ΔT = 25.0 K
Q = ?
m = 2.00 g = 0.002 kg
c = 2500 J/kg°C

Q = (0.002 kg)(2500)(25)
Q = 125 J

125 J − 7 J = 118 J
Methyl Alcohol needs 118 J more!

9. How many grams of mercury must be in a thermometer to show the same temperature increase as the methyl alcohol thermometer in #8 (if it received the same amount of energy)? (35.7 g)

m = ?
Q = 125 J
ΔT = 25.0 K
c = 140 J/kg°C

Q = mcΔT

$\frac{Q}{c\Delta T} = m$

$\frac{125\text{ J}}{(140\text{ J/kg°C})(25.0\text{ K})} = m$

m ≈ 0.0357 kg

m ≈ 35.7 g

10. A 15.75-g piece of iron absorbs 1086.75 joules of heat energy, and its temperature changes from 25°C to 175°C. Calculate the specific heat capacity of iron.

m = 15.75 g = 0.01575 kg
Q = 1086.75 J
T_i = 25°C
T_f = 175°C
c = ?

Q = mcΔT

$\frac{Q}{m\Delta T} = c$

$\frac{1086.75\text{ J}}{0.01575\text{ kg}(175\text{°C} - 25\text{°C})} = c$

c ≈ 460 J/kg°C

11. How many joules of heat are needed to raise the temperature of 10.0 g of aluminum from 22°C to 55°C, if the specific heat of aluminum is 0.90 J/g°C?

$Q = ?$
$m = 10.0\,g$
$T_i = 22°C$
$T_f = 55°C$
$c = 0.90\,J/g°C$

$Q = mc\Delta T$

$Q = 10.0\,g\,(0.90\,J/g°C)(55°C - 22°C)$

$Q \simeq 3.0 \times 10^2\,J$

12. To what temperature will a 50.0 g piece of glass raise if it absorbs 5275 joules of heat and its specific heat capacity is 0.50 J/g°C? The initial temperature of the glass is 20.0°C.

$m = 50.0\,g$
$Q = 5275\,J$
$c = 0.50\,J/g°C$
$T_i = 20.0°C$
$T_f = ?$

$Q = mc(T_f - T_i)$

$\frac{Q}{mc} = T_f - T_i$

$\frac{Q}{mc} + T_i = T_f$

$\frac{5275\,J}{50.0\,g\,(0.50\,J/g°C)} + 20.0°C = T_f$

$231°C = T_f$

13. Calculate the heat capacity of a piece of wood if 1500.0 g of the wood absorbs 6.75×10^4 joules of heat, and its temperature changes from 32°C to 57°C.

$c = ?$
$m = 1500.0\,g$
$Q = 6.75 \times 10^4\,J$
$T_i = 32°C$
$T_f = 57°C$

$Q = mc\Delta T$

$\frac{Q}{m\Delta T} = c$

$\frac{6.75 \times 10^4\,J}{(1500.0\,g)(57°C - 32°C)} = c$

$1.8\,J/g°C$ or $1800\,J/kg°C$

14. 100.0 mL of 4.0°C water is heated until its temperature is 37°C. If the specific heat of water is 4.18 J/g°C, calculate the amount of heat energy needed to cause this rise in temperature.

$Q = ?$
$m = 100.0\,g$
$T_i = 4.0°C$
$T_f = 37°C$
$c = 4.18\,J/g°C$

$Q = mc\Delta T$

$Q = 100.0\,g\,(4.18\,J/g°C)(37°C - 4.0°C)$

$Q \simeq 14000\,J$

15. Assuming that Coca Cola has the same specific heat as water (4.18 J/g°C), calculate the amount of heat in kJ transferred when one can (about 350g) is cooled from 25°C to 3°C .

$Q = ?$
$c = 4.18\,J/g°C$
$m = 350\,g$
$T_i = 25°C$
$T_f = 3°C$

$Q = mc\Delta T$

$Q = 350\,g\,(4.18\,J/g°C)(3°C - 25°C)$

$Q = -32186\,J$

$Q \simeq -32\,kJ$

16. Mercury (Hg) is the only metal that exists as a liquid at room temperature. Hg as a specific heat capacity of 0.140J/g°C. How many kilojoules of energy are required to increase 75.0kg of Hg from 23.0 to 52.0°C?

$c = 0.140\ J/g°C$
$Q = ?$
$m = 75.0kg = 75000g$
$T_i = 23.0°C$
$T_f = 52.0°C$

$Q = mc\Delta T$

$Q = 75000g(0.140J/g°C)(52.0°C - 23.0°C)$

$Q \approx 304500J$

$Q \approx 305kJ$

17. Titanium metal is used as a structural material in many high-tech applications such as jet engines. What is the specific heat of titanium (in J/g°C) if it takes 89.7 J to raise the temperature of a 33.0g block by 5.20°C?

$c = ?$
$Q = 89.7J$
$m = 33.0g$
$\Delta T = 5.20°C$

$Q = mc\Delta T$

$\frac{Q}{m\Delta T} = c$

$\frac{89.7J}{(33.0g)(5.20°C)} = c$

$0.523J/g°C = c$